Notes on the Distribution and Taxonomy of Short-tailed Shrews (Genus *Blarina*) in the Southeast

THOMAS W. FRENCH [1]
Department of Life Sciences,
Indiana State University, Terre Haute, Indiana 47809

ABSTRACT. — Seven hundred twenty-nine skulls of short-tailed shrews (genus *Blarina*) were examined from 152 counties in Alabama, Florida, Mississippi, North Carolina, South Carolina and Tennessee. One hundred ninety-three *B. brevicauda* and 265 *B. carolinensis* were compared by a stepwise discriminant analysis. Twenty-one central Tennessee specimens were compared to these two identified target samples. Although specimens from central Tennessee are scarce, the cranial measurements of some appear intermediate in size. Plots of the first two canonical variables show specimens from Hickman, Putnam and Warren counties, Tennessee as distinct from either *B. brevicauda* or *B. carolinensis* target clusters. A partial distribution map defining the ranges of *B. brevicauda* and *B. carolinensis* in the Southeast is presented. A possible disjunct population of *B. brevicauda* is reported from both sides of the Chattahoochee River in Alabama and Georgia.

INTRODUCTION

Short-tailed shrews of the genus *Blarina* are the most abundant and ubiquitous soricids in the Southeast. The taxonomy of this genus is currently undergoing revision, but recent publications (Genoways and Choate 1972; Ellis et al. 1978; Schmidley and Brown 1979; Tate et al. 1980) recognize a large northern form, *Blarina brevicauda*, and a small southern form, *Blarina carolinensis*, as distinct species. Another large phena, *B. telmalestes*, restricted to the vicinity of the Great Dismal Swamp of Virginia and North Carolina, is also currently recognized as distinct (Jones et al. 1979). Handley (1971) considered *B. brevicauda* and *B. carolinensis* to be entirely allopatric but contiguous, and Graham and Semken (1976) considered them to represent the parapatric coexistence of sibling species. Some early workers reported a zone of intergradation between the two phena which were then recognized as well differentiated subspecies (Merriam 1895; Cockrum 1952; Jones and Findley 1954), while others were unable to recognize intergrades (Rippy 1967; Schlitter and Bowles 1967). More recent workers have found individual areas of sympatry between *B. brevicauda* and *B. carolinensis*, both in Recent (Genoways and Choate 1972; Ellis et al. 1978; Tate et al. 1980) and Pleistocene material (Graham and Semken 1976), with only isolated cases of possible hybrids (Genoways and Choate 1972; Tate et al. 1980).

[1]Current address: Cooperative Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, New York 14853

Although these shrews are quite common, their exact ranges and thus the location of possible zones of sympatry are still not well known. The purpose of this paper is to more accurately define their ranges in the Southeast, to point out the intermediate nature of some Tennessee specimens, and to report a possible disjunct population of *B. brevicauda* in the upper Coastal Plain of Alabama and Georgia.

MATERIALS AND METHODS

Seven hundred twenty-nine *Blarina* skulls from 152 counties in Alabama, Florida, Mississippi, North Carolina, South Carolina, and Tennessee were examined. Five cranial measurements (condylobasal length, cranial breadth, interorbital breadth, maxillary breadth and maxillary toothrow length) were made to the neareest 0.1 mm with a vernier caliper following Jackson (1928). Specimens were measured regardless of sex or age, but included no nestlings.

Although age dimorphism has been documented by some (Guilday 1957; Choate 1972) and not by others (Ellis et al. 1978) *Blarina* is considered to be essentially adult size by the time it enters the trappable population (Guilday 1957; Dapson 1968; Ellis et al. 1978). The most noticeable differences between juvenile and adult *Blarina* are an increase in weight, total body length, and tooth wear, and a decrease in cranial height, with age. None of these characters was used to differentiate *B. brevicauda* and *B. carolinensis* in this study. Sexual dimorphism in *Blarina* has been recognized as slight by most workers, with males averaging slightly larger than females in some characters (Guilday 1957; Dapson 1968; Choate 1972; Ellis et al. 1978; Kirkland 1978). Others have reported no detectable sexual dimorphism (Graham and Semken 1976; Schmidley and Brown 1979). Neither age nor secondary sexual dimorphism of cranial characters appear to be significant when differentiating specimens of *B. brevicauda* and *B. carolinensis* in the trappable population. This presumption is supported by the near lack of overlap in cranial measurements between these two taxa reported by recent authors.

Body measurements were not used because standard body measurements were found to be variable, even within local populations, and especially because of obvious discrepancies in measuring techniques between various collectors. Guilday (1957) and Jones and Glass (1960) stressed that external measurements of *Blarina* (unless made by the same worker) should be used with caution in geographic studies. They also stressed that cranial measurements are much more constant and can be more accurately measured than body measurements. Sample body measurements of 50 *B. brevicauda* from Alabama and South Carolina are: total length 114.6 (101-125), tail length 25.2 (21.0-29.5), and hindfoot length 14.1 (12.5-15.5). Sample body measurements of 50 *B. carolinensis* from these same two states are: total length 92.2 (85-

104), tail length 19.7 (14-27), and hind foot length 11.2 (10.0-12.5).

Although specimens from central Tennessee are scarce, preliminary analysis of cranial measurements indicated that specimens from this area might be intermediate in size. A stepwise discriminant analysis was conducted on 265 *B. carolinensis* and 193 *B. brevicauda* with complete measurement data. The five previously described cranial measurements were used in this analysis and the specimens represent localities throughout the Southeast. Twenty-one central Tennessee specimens were then compared to these target samples. Seven of the central Tennessee specimens lacked condylobasal length and maxillary breadth measurements and two others lacked only maxillary breadth measurements due to breakage. Missing data were estimated for the nine specimens using the REGR option in the PAM subroutine of the Biomedical Computer Programs (Brown and Dixon 1979). In order to obtain a visual representation, the first two canonical variables were computed and plotted as described by Rao (1952) and used by Lawrence and Bossert (1967, 1969), Gipson et al. (1974), Kirkland and Van Deusen (1979), Parkinson (1979), Diersing (1980), and others. The Biomedical program PAM was used for these calculations.

RESULTS

The number of specimens examined from any one county varied from one to seventy-five. Small ranges in cranial measurements from large series suggest that small samples, other than from near the zone of contact, can usually be considered representative of the local population. Only slight overlap was found between the cranial measurements of all *B. brevicauda* and *B. carolinensis* (Table 1). Cranial measurements (mm) of two very recently weaned *B. brevicauda* from Alabama were condylobasal length 21.0 (broken); cranial breadth 11.2, 11.9; interorbital breadth 5.5, 5.8; and maxillary toothrow length 8.6, 8.9, maxillary breadth 7.6, 7.9.The lower range of each of these measurements is as great as or greater than the upper range of the same measurements from a mixed age sample of *B. carolinensis* from the Southeast (Table 1).

Perimeters of the extreme ranges of canonical variables for *B. brevicauda* and *B. carolinensis* are shown in Figure 1 to be nonoverlapping. Individual specimens from central Tennessee are identified in this figure by the first letter or letters of the county in which they were collected (Anderson, Davidson, Franklin, Hickman, Marion, Putnam, Warren and Wayne).

The most striking pattern is the clustering of the Hickman, Putnam and Warren county specimens well outside the range of both *B. brevicauda* and *B. carolinensis* canonical clusters. The Marion County specimen appears properly identified as a *B. carolinensis*, although it is located on the edge of this distribution. Seven Anderson and one Frank-

Table 1. Cranial measurements of *Blarina* from the southeastern United States. The first line for each measurement includes the mean and the number of specimens examined (in parentheses). The second line is the range and the third line is the standard deviation.

	Condylobasal length	Cranial breadth	Maxillary toothrow length	Interorbital breadth	Maxillary breadth
Blarina carolinensis	18.72 (273)	10.25 (251)	7.15 (375)	5.08 (360)	6.61 (371)
	17.4-20.1	9.4-10.9	6.6-7.7	4.6-5.5	6.0-7.1
	0.43	0.28	0.21	0.16	0.20
Blarina sp. (Hickman, Putnam & Warren cos., TN)	20.17 (3)	11.60 (3)	7.43 (6)	5.27 (6)	8.07 (6)
	20.0-20.3	11.4-11.9	7.2-7.7	5.1-5.5	7.8-8.4
	0.15	0.27	0.20	0.16	0.22
Blarina sp. (Anderson, Davidson, Franklin, Lincoln & Wayne cos., TN)	20.88 (11)	11.69 (9)	8.03 (14)	5.42 (14)	7.34 (14)
	20.0-21.7	11.2-12.3	7.7-8.3	5.1-5.9	6.8-7.9
	0.57	0.39	0.21	0.23	0.33
Blarina brevicauda	21.88 (229)	12.03 (201)	8.55 (283)	5.61 (288)	7.67 (290)
	20.2-23.1	11.1-13.0	7.8-9.4	4.9-6.3	6.8-8.7
	0.57	0.35	0.28	0.25	0.26

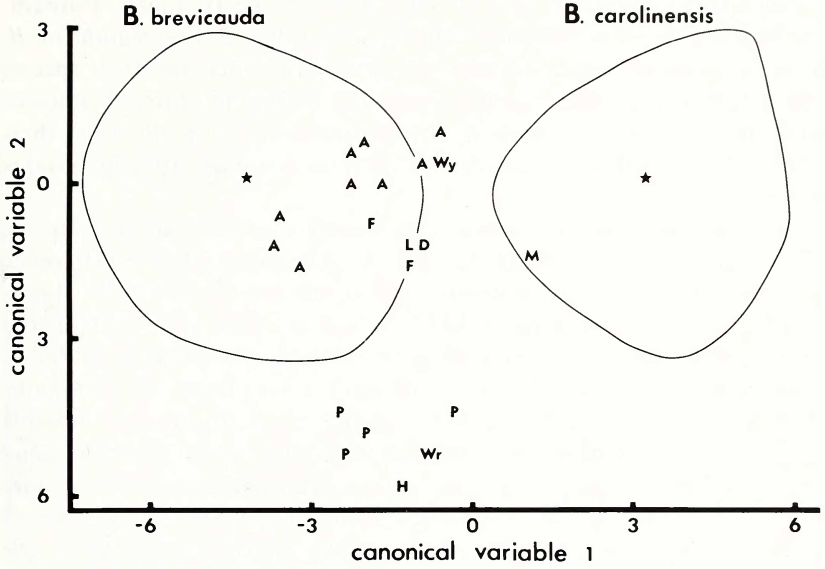

Fig. 1. Relationships of 479 *Blarina* from the Southeast as plotted by discriminant analysis (BMD P7M). Stars represent group means for *B. brevicauda* and *B. carolinensis*. Letters represent individual specimens from central Tennessee and are the first letter or letters of the counties in which the shrews were collected (Anderson, Davidson, Franklin, Hickman, Marion, Putnam, Warren and Wayne).

lin County specimens fall within the *B. brevicauda* cluster, but the remaining specimens are located outside the limits of this cluster and intermediate to the two *Blarina* species.

Blarina from Anderson, Davidson, Franklin, Lincoln and Wayne counties are probably best referred to as *B. brevicauda* and the Marion County specimen as *B. carolinensis*. The possibility of hybridization or intergradation between the two forms of *Blarina*, however, should not be ruled out.

Most Tennessee *B. brevicauda* are found in the mountainous parts of the state on the eastern and northern borders. Wayne County is located on the Highland Rim and is not particularly high in elevation, but the shrews from Franklin and Lincoln counties were collected on the Cumberland Plateau at about 2000 feet (610 m) elevation. These large shrews might represent a relict population of *B. brevicauda*, but it seems more likely that they are joined to other *B. brevicauda* populations along the length of the Cumberland Plateau. If this is true, large specimens of *Blarina* should be looked for at higher elevations in counties such as Bledsoe, Cumberland, Grundy and Sequatchie.

Many authors (Lawrence and Bossert 1967, 1969; Gipson et al. 1974; Kirkland and Van Deusen 1979; Parkinson 1979; and others) have

attributed the magnitude of difference between the Hickman, Putnam, and Warren counties canonical cluster and either *B. brevicauda* or *B. carolinensis* target clusters as representative of distinct species or species hybrids. Although these results suggest that *Blarina* in central Tennessee might be distinct from both *B. brevicauda* and *B. carolinensis*, their correct identity will remain uncertain until more comparative material is available.

I produced (Fig. 2) a partial distribution map of *Blarina* using the five cranial characters as species criteria. The most notable difference between this and other distribution maps (Hall and Kelson 1959; Handley 1971; Graham and Semken 1976; Tate et al. 1980; and others) is the south and westward extension of *B. brevicauda* (synonym = *B. brevicauda churchi*) approximately 195 miles (314 km) from the mountains of Georgia into the Piedmont of Alabama. Also indicated is a possible disjunct population of *B. brevicauda* on both sides of the Chattahoochee River, Barbour County, Alabama, and in Quitman and Stewart counties, Georgia. In Alabama the largest form was overlooked by Howell (1921) because none of his specimens of *Blarina* came from the Piedmont.

Much of the southeastern distribution of these shrews approximates well established physiographic boundaries (see Fenneman 1938 and Hunt 1964 for descriptions of physiographic provinces). In North Carolina the boundary between the two species roughly follows the eastern edge of the mountains, but in South Carolina it extends southward through the Piedmont and meets the Savannah River near the center of this physiographic province. In Georgia and Alabama the boundary closely follows the Fall Line, and in Alabama it swings northeastward along the south edge of the Great Valley (between the Piedmont and Ridge and Valley physiographic provinces). In Tennessee it follows the western edge of the Smoky Mountains and appears to swing around the southern edge of the Cumberland Mountains and south of the Cumberland River. Although habitat features are often considerably different in adjacent physiographic provinces, I know of no reason why these features should limit the distribution of either form of *Blarina*.

Blarina brevicauda was discovered at three localities south of the Fall Line in Georgia and Alabama. There are few specimens (10), but the three localities appear to represent a disjunct population separated from the Piedmont populations by only about 25 air miles (40 km). The only other known disjunct populations of large Coastal Plain *Blarina* are *B. brevicauda shermani* on the Gulf coast of Florida and *B. telmalestes* in the Great Dismal Swamp of Virginia and adjacent North Carolina. Two large specimens (U.S. National Museum #268977 and North Carolina State Museum #2575) were also examined from the Coastal Plain of North Carolina (Sampson and Columbus counties). These are the only individuals examined from each of these two counties. The

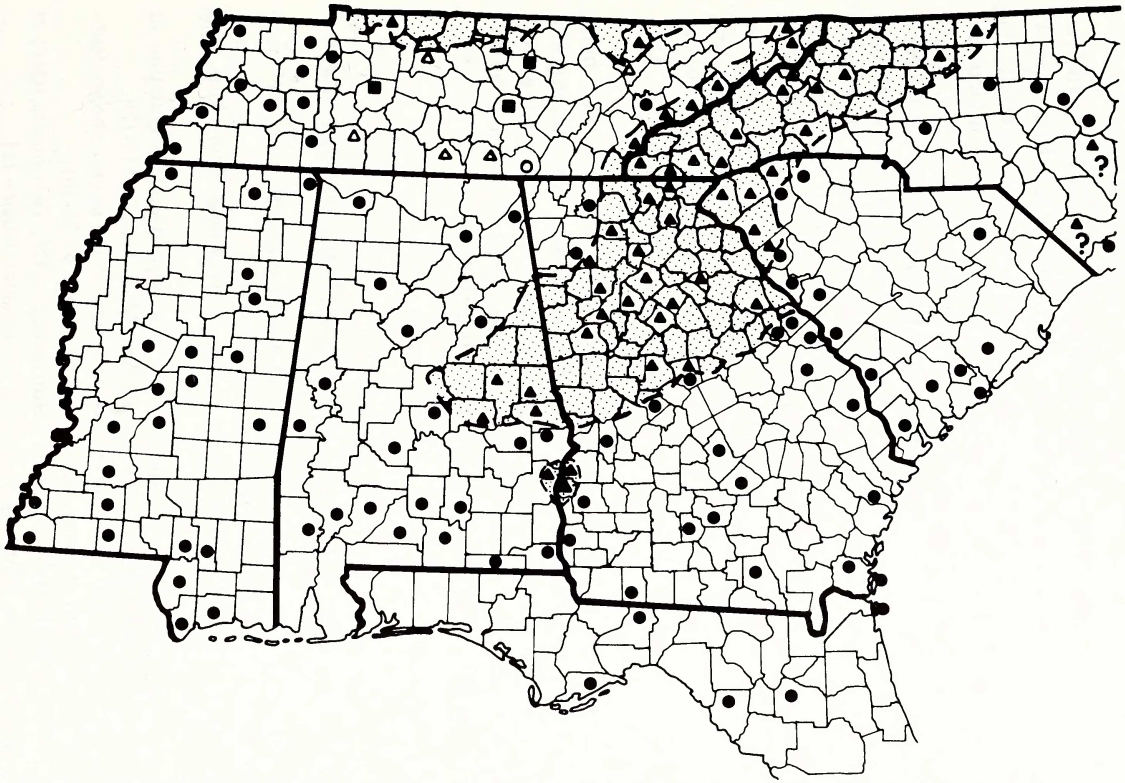

Fig. 2. Partial distribution of *Blarina* in the Southeast. Triangles represent *B. brevicauda*, circles *B. carolinensis*, and squares intermediate *Blarina* in central Tennessee. Open triangles represent central Tennessee *Blarina* that appear referable to *B. brevicauda* used in the multivariate analysis. The open circle represents the Marion County, TN specimen referable to *B. carolinensis* used in the analysis.

specimens were collected at least 110 miles (177 km) east of *B. brevicauda* populations of the North Carolina Piedmont and 125 miles (201 km) southwest of the nearest known *B. telmalestes* populations. Additional work is needed in the North Carolina Coastal Plain.

ACKNOWLEDGMENTS.— Appreciation is extended to the following persons who allowed me to examine specimens under their care: R. J. Baker, Texas Tech University; R. Bauer, Cornell University; G. Breece, Georgia Power Co., Atlanta; J. E. Cadle, University of Georgia; C. Carter, Mississippi Museum of Natural Science, Jackson; J. L. Dusi, Auburn University; R. D. Fisher, National Museum of Natural History; P. Goldstein, American Museum of Natural History; D. C. Holliman, Birmingham Southern College; M. Kennedy, Memphis State University; D. S. Lee, North Carolina State Museum of Natural History; J. P. O'Neill, Louisiana State University; J. F. Parnell, University of North Carolina at Wilmington; C. Ruckdeschel, Cumberland Island, GA; A. E. Sanders, Charleston Museum; S. Scudder, Florida State Museum, University of Florida; C. H. Wharton, Georgia State University; W. K. Willard, Tennessee Technological University; and H. C. Yeatman, University of the South.

Special thanks are due A. E. Sanders and J. L. Dusi for their help, and J. O. Whitaker, Jr., Indiana State University, for reading the manuscript. The comments of two anonymous reviewers were also greatly appreciated. Computer funds and typing were supplied by the Cooperative Wildlife Research Unit, Cornell University.

LITERATURE CITED

Brown, M. B., and W. J. Dixon (eds.). 1979. Biomedical computer programs P series. Univ. Calif. Press, Berkeley. 880 pp.

Choate, Jerry R. 1972. Variation within and among populations of the short-tailed shrew in Connecticut. J. Mammal. *53*:116-128.

Cockrum, E. Lendell. 1952. Mammals of Kansas. Univ. Kansas Publ. Mus. Nat. Hist. 7:1-303.

Dapson, Richard W. 1968. Growth patterns in a post-juvenile population of shorttailed shrews *(Blarina brevicauda)*. Am. Midl. Nat. *79*:118-129.

Diersing, Victor E. 1980. Systematics and evolution of the pygmy shrews (subgenus *Microsorex*) of North America. J. Mammal. *61*:76-101.

Ellis, L. Scott, V. E. Diersing and D. F. Hoffmeister. 1978. Taxonomic status of short-tailed shrews *(Blarina)* in Illinois, J. Mammal. *59*:305-311.

Fenneman, Nevin M. 1938. Physiography of Eastern United States. McGraw-Hill Co., Inc., New York. 689 pp.

Genoways, Hugh H., and J. R. Choate. 1972. A multivariate analysis of systematic relationships among populations of the short-tailed shrew (genus *Blarina*) in Nebraska. Syst. Zool. *21*:106-116.

Gipson, Philip S., J. A. Sealander and J. E. Dunn. 1974. The taxonomic status of wild *Canis* in Arkansas. Syst. Zool. *23*:1-11.

Graham, Russell W., and H. A. Semken. 1976. Paleoecological significance of the short-tailed shrew *(Blarina)*, with a systematic discussion of *Blarina ozarkensis*. J. Mammal. *57*:433-449.

Guilday, John E. 1957. Individual and geographic variations in *Blarina brevicauda* from Pennsylvania. Ann. Carnegie Mus. *35*:41-68.

Hall, E. Raymond, and K. R. Kelson. 1959. The Mammals of North America. Ronald Press, New York. 546 pp.

Handley, Charles O., Jr. 1971. Appalachian mammalian geography -- Recent Epoch. pp. 263-303 *in* P. C. Holt (ed.). The distributional history of the biota of the southern Appalachians, Part III: Vertebrates. Res. Div. Monogr. 4, Va. Polytech. Inst. State Univ., Blacksburg. 306 pp.

Howell, Arthur H. 1921. Mammals of Alabama. N. Am. Fauna 45. 88 pp.

Hunt, Charles B. 1967. Physiography of the United States. W. H. Freeman and Co., San Francisco. 480 pp.

Jackson, Hartley H. T. 1928. A taxonomic review of the American long-tailed shrews. N. Am. Fauna 51. 238 pp.

Jones, J. Knox, Jr., and J. S. Findley. 1954. Geographic distribution of the short-tailed shrew, *Blarina brevicauda*, in the Great Plains. Trans. Kans. Acad. Sci. *57*:208-211.

_____, and B. P. Glass. 1960. The short-tailed shrew, *Blarina brevicauda*, in Oklahoma. Southwest. Nat. *5*:136-142.

_____, D. C. Carter and H. H. Genoways. 1979. Revised checklist of North American mammals north of Mexico, 1979. Occas. Pap. Mus. Texas Tech. Univ. *62*:1-17.

Kirkland, Gordon L. 1978. The short-tailed shrew, *Blarina brevicauda* (Say), in the central mountains of West Virginia. Proc. Pa. Acad. Sci. *52*:126-130.

_____, and H. M. Van Duesen. 1979. The shrews of the *Sorex dispar* group: *Sorex dispar* Batchelder and *Sorex gaspensis* Anthony and Goodwin. Am. Mus. Novit. 2675:1-21.

Lawrence, Barbara, and W. H. Bossert. 1967. Multiple character analysis of *Canis lupus, latrans* and *familiaris*, with a discussion of the relationships of *Canis niger*. Am. Zool. *7*:223-232.

_____, and _____. 1969. The cranial evidence for hybridization in New England *Canis*. Breviora *330*:1-13.

Merriam, C. Hart. 1895. Revision of the shrews of the American genera *Blarina* and *Notiosorex*. N. Am. Fauna *10*:5-34.

Parkinson, Aida. 1979. Morphologic variation and hybridization in *Myotis yumanensis sociabilis* and *Myotis lucifugus carissima*. J. Mammal. *60*:489-504.

Rao, Calyampudi R. 1952. Advanced statistical methods in biometric research. John Wiley & Sons, New York.

Rippy, Charles L. 1967. The taxonomy and distribution of the short-tailed shrew, *Blarina brevicauda*, in Kentucky. Unpubl. M.S. thesis, Dept. Zool., Univ. Ky., Lexington. 83 pp.

Schlitter, Duane A., and J. B. Bowles. 1967. Noteworthy distributional records of some mammals in Iowa. Trans. Kans. Acad. Sci. *70*:525-529.

Schmidley, David J., and W. A. Brown. 1979. Systematics of short-tailed shrews (genus *Blarina*) in Texas. Southwest. Nat. *24*:39-48.

Tate, Cathy M., J. F. Pagels and C. O. Handley, Jr. 1980. Distribution and systematic relationship of two kinds of short-tailed shrews (Soricidae: *Blarina*) in south-central Virginia. Proc. Biol. Soc. Wash. *93*:50-60.

Accepted 20 March 1981